ISSUE PAPER:

TREATMENT OF UNCERTAINTY IN AMBIENT PM_{10} MEASUREMENTS

Prepared by

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ISSUE: Field comparisons of various different types of PM_{10} samplers generally indicate consistent measurement differences or "relative biases" between or among the different samplers, suggesting uncertainty in the PM_{10} measurements. The magnitude of this uncertainty, which appears to be somewhat greater than corresponding uncertainties associated with gaseous pollutants, raises questions and concerns about the utilization of PM_{10} data in the determination of attainment of the NAAQS and in the development of SIPs.

INTRODUCTION

Background on PM_{10} Measurement Method

The nature of particulate matter in the atmosphere is very complex. Airborne particles exist in a wide variety of sizes, shapes, density, surface characteristics, chemical composition and other features. Various equilibria may exist between the volatile, semi-volatile, and non-volatile components of the atmospheric particle mixture. Consequently, measurement of particulate matter in the ambient air, especially in the 0 to 10 micrometer size range (PM_{10}), is difficult. Various mechanical techniques for discrimination and collection of particles in the PM_{10} size range are likely to perform somewhat differently, depending on the particular characteristics of the particles in the atmosphere being sampled. Further, PM_{10} measurements will tend to be somewhat characteristic of the type of sampler used, and measurements from different types of samplers are likely to be characteristically discrepant, to some extent. Finally, since no absolute concentration standard for particulate matter exists, particulate matter samplers cannot be calibrated against known reference materials, as is done in the measurement of single-compound gaseous pollutants such as SO_2, NO_2, CO and O_3. Accordingly, PM_{10} measurement methods can provide only estimates of the "true" PM_{10} concentrations.

The recently promulgated Federal Reference Method (FRM) for PM_{10} (40 CFR Part 50, Appendix J) specifies an integrated 24-hour PM_{10} measurement based on discrimination of particles in the PM_{10} size range by inertial separation, followed by conventional filtration of a measured volume of sampled air and determination of the net weight gain of the filter. Under these new FRM requirements and associated requirements in 40 CFR Part 53, PM_{10} samplers are specified by performance (i.e., wind tunnel tests for sampling effectiveness and 50 percent cutpoint and field tests for precision and flow rate stability) rather than by sampler design specifications. This approach was taken to provide greater engineering flexibility to allow for the use of various existing sampler designs and to encourage continuing improvements and innovative new sampler designs. But in providing this design flexibility, the performance specification approach inherently allows for some measurement differences between approved PM_{10} samplers due to the necessary tolerances in the performance specifications (e.g., D50 cut-point: 10 ± 0.5 micrometers, expected mass: $\pm 10\%$). It was anticipated that samplers which meet the performance requirements would provide PM_{10} measurements within a 10 percent range at the majority of the required sampler locations.

Observed Measurement Differences Among PM_{10} Samplers

Ambient PM_{10} concentration data have been collected with a variety of samplers over the last several years. These include high-volume samplers currently designated as PM_{10} reference methods, earlier commercially available versions or prototypes of reference method samplers, and low volume dichotomous samplers. The PM_{10} sampler type most commonly used has been the Sierra-Andersen (SA) high volume sampler, which was procured and distributed to many state and local monitoring agencies by EPA. There also have been a substantial number of Wedding & Associates (Wedding) high-volume PM_{10} samplers in use, as well as a limited number of low-volume dichotomous (dichot) samplers with PM_{10} inlets manufactured by both SA and Wedding.

Significant characteristic differences between PM_{10} measurements from earlier versions of the SA and Wedding samplers were identified during several field studies designed to evaluate sampler performance. Generally, SA samplers produced higher concentration measurements than Wedding samplers. These observed differences indicated uncertainty in the PM_{10} measurements. But the characteristic differences between these dissimilar sampler types were significant and separate from the random uncertainty that is associated with the overall measurement process. These differences are referred to as "relative biases" or "biases", because they can be quantified only on a relative basis, since no absolute PM_{10} reference standard exists.

Sampler manufacturers have incorporated various improvements into their respective samplers, resulting in the versions that are currently in use and have been recently designated as reference methods for PM_{10} under the provisions of 40 CFR Part 53. Although the improvements substantially reduced the relative biases observed between the SA and Wedding samplers, subsequent field studies have indicated that residual biases still exist between these reference method samplers. The biases are variable and site-dependent to some extent. Variations may also be related to seasonal changes, weather, or other local variables. Average differences between EPA-designated, collocated SA and Wedding samplers varied between 5 and 15 percent at four locations.

Differences between earlier SA and Wedding sampler versions were somewhat greater. Since PM_{10} reference method samplers have been part of State and local air monitoring stations since early 1988, the PM_{10} data currently being collected should be less uncertain than data collected with earlier versions. EPA is continuing to work with sampler manufacturers to try to identify the causes of the biases and to further reduce them.

Current Interpretation and Use of PM_{10} Measurement Data

PM_{10} data is essential in the determination of attainment/non-attainment status and in the development of SIPs. At the time of the promulgation of the PM_{10} standards, available PM_{10} data was analyzed together with historical TSP data to estimate current PM_{10} air quality status and to group areas for SIP development purposes. Uncertainty was recognized in existing PM_{10} measurements, and "gray" uncertainty zones were utilized to interpret these data to predict the probability of attainment with the standards. A gray uncertainty zone of 0 to +20 percent was placed around the level of the standard for data produced by the SA sampler, and a zone of 0 to -20 percent was employed for data from Wedding samplers. Using existing PM_{10} monitoring data that was outside of these gray zones, areas could be categorized as either likely to be in non-attainment (Group I), or likely to be in attainment (Group III). When PM_{10} data fell into the applicable gray zone, the area was categorized as too close to call (Group II) and additional time was given to collect more PM_{10} data and ascertain unequivocable attainment status.

The gray zones were derived from the results of a field study conducted in Phoenix, Arizona, which indicated that differences between SA and Wedding samplers of plus or minus 20 percent were possible. At that time, EPA believed that the Phoenix test site was atypical and that measurements from existing samplers would be in better agreement in more typical sampling sites. Therefore, EPA's guidance for subsequent SIP development stated that "data collected with all instruments will be taken at face value when demonstrating attainment or non-attainment with the standards." However, to allow for the possibility that potential sampler bias could exist in specific locations, the guidance also stated that an appropriate adjustment would be permitted for attainment demonstrations if influence by coarse particles could be demonstrated.

Since a determination of attainment with the PM_{10} standards generally requires at least 3 years of monitoring data, existing guidance allows that both newer reference method data as well as older unapproved method data may be utilized for these assessments. In light of the results from recent field studies of PM_{10} samplers, questions and concerns continue to be raised as to the treatment of the uncertainties in PM_{10} data from both reference method samplers and earlier versions in the application of the data to the attainment and SIP determination processes. Accordingly, this paper addresses this issue, and recommends a policy for interpretation of PM_{10} data to facilitate these processes.

Options

A joint OAQPS/EMSL committee has evaluated this issue and identified three cases where the treatment of uncertainties of PM_{10} monitoring data should be considered. The first and most important case is the treatment of PM_{10} data obtained currently or previously with EPA-designated reference method samplers. This case primarily addresses many of the data collected during the past year and all future data collected for determining attainment status with the PM_{10} standards. The second case is the treatment of data collected over the last two or three years with earlier, unapproved samplers (non-EPA-designated). This case addresses data collected with earlier unapproved versions of the SA and Wedding PM_{10} samplers and applies only to data collected prior to August 1, 1988. (Under the provisions of 40 CFR Part 58, approved PM_{10} samplers must be operational for attainment purposes after this date.) Finally, the third case addresses the special situation where two or more samplers are collocated and produce concurrent PM_{10} monitoring data.

The committee identified three possible optional approaches for contending with the uncertainty in the PM_{10} data with respect to the attainment and SIP determinations for cases I and II identified above. Two of the options are further divided into two suboptions. The options are:

1. Use all PM_{10} measurement data at face value.

2. Adjust PM_{10} measurement data with adjustment factors developed for each type of sampler:

   A. Universal factors used nationwide.

   B. Site-specific factors.

3. Use PM_{10} measurement data selectively:

   A. By defining a particular specific sampler as "correct" or as the "reference sampler".

   B. By using a "gray zone" in interpreting and using PM_{10} data from the various PM_{10} samplers.

These options are addressed individually, highlighting the positive and negative aspects of each with respect to cases I and II. Since all of the optional approaches have significant drawbacks or disadvantages, selection of the best option for each category of data involves careful evaluation and weighing of the tradeoffs between the various advantages and disadvantages. The nature of case III is somewhat different from cases I and II and four special alternatives are discussed for this case.

I. TREATMENT OF PM_{10} DATA OBTAINED WITH EPA-DESIGNATED REFERENCE METHOD SAMPLERS

OPTION 1: Use all PM_{10} measurement data at face value.

In this approach, all validated PM_{10} concentration data from any approved reference (or equivalent) sampler are reported and used at face value with full authority, just as data for other criteria pollutants are reported and used.

No special adjustments are made or special treatments are utilized. All pollutant measurements contain uncertainty, and this uncertainty is accommodated in the policies governing the appplication of the measurement data. Differences between PM_{10} data from dissimilar samplers would be viewed as a component of the overall uncertainty associated with PM_{10} monitoring data and accommodated in the same way as for the other pollutants.

Advantages

1. This approach is entirely consistent with the established data reporting and utilization mechanism established for the other criteria pollutants. No changes or deviations are required for PM_{10}. There will be no delay before the data are available for use, and no additional effort or resources are needed to process or interpret the data.

2. The approach implies adequacy of the data and avoids undermining its credibility by not drawing attention to problems or questions of data quality and applicability.

3. This approach supports the FRM concept of functional specifications for PM_{10} samplers and reaffirms EPA's confidence in and commitment to that concept. Further, it represents the ultimate ideal goal as the sampler manufacturers continue to improve the samplers and reduce or eliminate significant bias between different sampler models.

4. The approach is reasonable in the sense that all criteria pollutant measurements contain uncertainty to some extent, and accepting a higher level of uncertainty for particulate matter measurements than for gaseous pollutant measurements is not inappropriate. If a substantial bias exists between two samplers, it is reasonable to assume that the "true" concentration lies between the two estimates. Therefore a bias of as high as 15 to 20% may represent an actual error of only 5 to 10% or less. That level of uncertainty is not unacceptable in the context of other uncertainties in the air quality assessment process, such as locating a sampler at a point of maximum pollutant impact, losses of semi-volatile particles from the filter, other operational errors inherent in any particle collection method, and the recognized uncertainty associated with the use of dispersion models.

5. The approach is defensible because the advantages listed above are reasonably clear, readily supportable, and can be weighted heavily in comparison to the disadvantages and to the relative advantages of other approaches.

Disadvantages

1. The uncertainty in PM_{10} measurements appears to include a relative bias reflected by a consistent difference between measurements produced by different sampler types. The magnitude of this uncertainty is apparently

larger than uncertainties associated with other criteria pollutants. Perhaps more significant, the PM_{10} uncertainties may exceed a level of 10%, which is widely perceived as an upper limit of acceptability for data uncertainty. If the higher levels of uncertainty in the PM_{10} data can be justified as acceptable (see advantage #4), this may not represent a profound problem.

2. To the extent that relative biases exist among various types of samplers, monitoring agencies and certainly industry may strive to use the lowest-reading sampler available. Correspondingly, sampler manufacturers may try to modify or redesign their samplers to provide relatively lower PM_{10} measurements while still meeting the EPA sampler performance test specifications.

3. This approach does not deal directly with whatever bias problem may exist and may be perceived as failure to take action to address the problem. It also places a burden on the EPA to continue to perform field studies to ensure that approved samplers are operating according to expectations and that biases between approved samplers are identified and addressed.

4. Where bias exists between two types of PM_{10} samplers, replacing one sampler with another at a particular site may present a problem in trends analysis at the site. Similarly, the further improvements and reduction of biases between samplers that is expected to occur,though it may result in only small changes, could interfere with trends analysis. Finally, although current guidance for collocation sampling for precision assessment strongly recommends use of similar-type samplers, monitoring agencies that collocate dissimilar PM_{10} sampler types (for whatever reason) could be faced with dealing with characteristically discrepant measurements from the two samplers. See Case III (Treatment of PM_{10} data obtained concurrently with collocated samplers) for further discussion of this situation.

OPTION 2: Adjust PM_{10} measurements with adjustment factors developed for each type of sampler on either (A) a universal, nationwide basis or (B) a site-specific basis.

Under this approach all validated PM_{10} data collected with approved samplers would be adjusted in an attempt to reduce or eliminate the observed biases between the different sampler types. Relative bias would have to be quantified and apportioned to the various samplers in some logical and equitable fashion to establish the various adjustment factors. This process could be based on all available comparative PM_{10} sampler data to establish universal factors for nation-wide application. However, since sampler biases are likely to be site-dependent, factors developed on a site-specific basis would likely be more accurate and more credible.

An adjustment factor can be viewed as simply a means of fine-tuning the accuracy of a PM_{10} sampler, which lacks any physical means for doing so. As such, the adjustment serves the same purpose as the span control on a gaseous pollutant analyzer. The only difference is that since no absolute concentration standards exist for PM_{10}, the factor cannot be determined in an absolute sense and therefore must necessarily be established on a relative basis.

Advantages

1. This approach addresses the bias problem actively and directly, presumably reducing the biases (and hence the uncertainty in the PM_{10} data) to levels comparable to those of other criteria pollutants.

2. Once the data corrections are accomplished, the data may be stored, retrieved and used via the same mechanisms used for other pollutants, with the same authority and with no further special considerations. Data credibility would be restored and with the use of a universal factor (developed by EPA), no additional burdens on state or local reporting agencies would be imposed.

3. Reductions of bias among various samplers will greatly reduce the tendency for industry and monitoring agencies to select or switch samplers to obtain the lowest PM_{10} measurements. Accordingly, manufacturers will be under much less pressure to arbitrarily modify or redesign samplers for lower PM_{10} measurements to compete successfully in the sampler marketplace. Equitable allocation of the relative adjustment factors will not favor any one manufacturer.

4. Use of site-specific adjustment factors could more effectively reduce observed biases at individual sites and therefore mitigate site-to-site variations in biases that would not be addressed with universal sampler adjustment factors applied nationwide.

5. If sampler biases are effectively reduced with appropriate adjustment factors, there could be less incentive for manufacturers to redesign already approved samplers. This would introduce stability into the collection and reporting of PM_{10} measurements.

Disadvantages

1. Even though the adjustment factors need not be established on an absolute basis, quantitative determination of the relative factors is difficult because of the variations observed at different sites and under different conditions. Existing test data are not sufficient. Additional field testing of samplers to obtain more complete relative bias data is very expensive, and the site-dependence of the relative biases is not well enough understood to accurately categorize various sites to insure adequate representation of the test sites. Other variables such as sampler maintenance, seasonal variations, weather, and other local variables further complicate the testing. Also, weather and other seasonal variations raise the question of whether the site-specific adjustment should be season specific.

2. Newly-approved samplers would definitely have to be tested for relative bias with respect to previously approved samplers, since there would be no existing test information. Since bias adjustments would be made on a relative basis among approved samplers, rather than against a known standard, data from the new sampler (or any new test data that become

available) might necessitate new adjustment factors. The resulting changes would interfere to some extent with trends analyses and previous attainment determinations.

3. Establishment of relative adjustment factors would almost certainly be viewed negatively by the sampler manufacturers, particularly manufacturers of samplers characteristically producing the lowest PM_{10} measurements. Any manufacturer could claim its own sampler as most nearly "correct" and thus object to adjustments of its sampler's data to accommodate claimed "error" in the PM_{10} data from its competitors' samplers.

4. The approach would be subject to criticism and somewhat difficult to defend. Since the adjustment factors would be based on relative bias among the samplers and not on an absolute basis, the adjustment factors would have to be supported with arguments based on logic and expediency rather than on absolute scientific accuracy.

5. Adjustments to PM_{10} data could raise difficulties or undermine the confidence in the performance or comparative tests for reference and equivalent methods, because such factors would be relative rather than absolute. Any subsequent change in the correction factor associated with the reference method used in an equivalent method comparative test could bring the validity of the equivalent method designation into question.

6. If sampler biases are effectively reduced with appropriate adjustment factors, there could be much less incentive for further modification or redesign of already approved samplers to further reduce relative biases, which should be the ultimate goal.

7. Because of site-to-site variations in the biases, application of a universal adjustment factor could actually be counter productive in some specific cases.

8. Implementation of site-specific adjustment factors appears to be impractical. Who would be responsible to develop the individual factors? Who would keep track of so many factors? Would individual factors be developed for each monitoring site or could factors be developed for all sites in a larger monitoring area? What basis could be used to define such a larger area? It would seem to be prohibitively costly to try to obtain test data at each individual site. How would data from a particular site be treated before the appropriate adjustment factor was established?

OPTION 3A: Use PM_{10} measurement data selectively by defining a particular specific sampler as "correct" or as the "reference sampler."

This option would select one type of PM_{10} sampler as the "best" or the one that produces measurements "closest to the true PM_{10}" concentration. The selected sampler would be designated as the "reference" sampler, and all PM_{10} data collected with any other type of sampler presumably would be adjusted, to the best extent possible, to eliminate bias with respect to the reference sampler.

Advantages

1. The advantages for this option are essentially the same as those listed for Option 2 (adjustment of PM_{10} measurements with sampler-specific factors). In addition, the option would be simple in concept and straightforward to implement.

Disadvantages

1. This approach has the serious disadvantage that it is in conflict with the performance specification concept promulgated in 40 CFR Parts 50 (Appendix J) and 53. Thus, adoption of this approach would appear to require extensive revision and repromulgation of those regulations. Changing the regulations would result in extensive disruption of current monitoring, substantial delay before revised regulations are in place, and the need for an interim policy for treatment of PM_{10} data collected prior to implementation of the revised regulation.

2. There is little basis for selection of the "best" sampler for reference method status, given the present state of the art of PM_{10} monitoring and the lack of absolute PM_{10} standards. Thus, the selection would be largely arbitrary. Manufacturers of nonselected samplers would surely object very strongly, and the approach will be difficult to support on a scientific basis.

3. This option would be equivalent to the design approach concept for specifying PM_{10} samplers that was rejected during the development of the current PM_{10} reference method because of the need for technical flexibility in sampler types and design approaches.

OPTION 3B: Use PM_{10} measurement data selectively by using a "gray zone" in interpreting and using PM_{10} data from the various PM_{10} samplers.

Under this approach, data would be reported and stored at face value. However, during use of the data, a "zone of uncertainty" (gray zone) would be associated with the PM_{10} measurements, and the true measurement would essentially be viewed as an interval of possible values. For the critical comparisons with the level of the PM_{10} standards, the zone would be defined around the level of the standard, as was previously done for SIP area groupings. The magnitude of the zone would reflect the estimated uncertainty for the sampler used, and the zone would be nonsymetrical or offset (+0% to -15%, for example), depending on the magnitude of the relative bias among PM_{10} samplers. PM_{10} concentrations within the gray zone would be considered less authoritatively than concentrations outside the gray zone.

Advantages

1. No changes are needed to PM_{10} data collected either previously or currently with reference method samplers.

2. Less attention would be drawn to problems of data quality or credibility than the correction factors of Option 2.

3. The approach acknowledges the bias problem and provides a mechanism to consider the effects of relative biases between samplers during data interpretation. The approach was used successfully in the previous area grouping process to establish initial PM_{10} sampling requirements.

4. This approach is consistent with the FRM concept of functional specifications for PM_{10} samplers.

5. Consideration of the effects of relative bias among various samplers will reduce the tendency for industry and monitoring agencies to select or switch samplers to obtain the lowest PM_{10} measurements. Accordingly, manufacturers will be under less pressure to arbitrarily modify or redesign samplers for lower PM_{10} measurements to compete successfully in the sampler marketplace.

Disadvantages

1. A separate and substantially different interpretation process than the process currently used with reference or equivalent data for the other criteria pollutants would be required. This will result in possible confusion among data users in knowing exactly what the special treatment process is and considerable additional effort in learning and carrying out the different process for PM_{10} data.

2. Less stringent enforcement of PM_{10} concentrations that fall within the gray zone may be regarded as relaxation of the PM_{10} standards and prove to be embarassing to EPA.

3. This approach may delay the attainment determination process. It could require additional time and or data to determine attainment and shorten the available time for control strategy implementation.

4. The width and offset parameters for the gray zones must be established for each sampler. Quantitative determination of these parameters must be made on a relative basis and will be difficult because of the variations in biases observed at different sites and under different conditions. Existing test data is not sufficient. Additional field testing of samplers to obtain more complete relative bias data is very expensive, and the site-dependence of the relative biases is not well enough understood to accurately categorize various sites to insure adequate representation of the test sites. Other variables such as sampler maintenance, seasonal variations, weather, and other local variables further complicate the testing.

5. Newly-approved samplers would have to be tested for relative bias with respect to previously approved samplers, since there would be no existing test information to use as a basis to establish the gray zones. Moreover, the bias data from the new sampler (or any new bias test data that becomes available) might necessitate changes to other gray zone parameters.

6. Establishment of the gray zones will tend to reduce the credibility of the PM_{10} data, and therefore enforcement may be more difficult. The approach would be subject to criticism because the gray zones would be based on relative bias among the samplers and not on an absolute, scientific basis.

Recommendation

Upon weighing and evaluating the various advantages and disadvantages of the three optional approaches, we believe that option 1, use of all PM_{10} data at face value, is clearly the best course of action. The approach fully supports the FRM functional specification concept that provides the technical flexibility needed for competitive sampler innovation, and it is fully consistent with the interpretation of data for the other criteria pollutants. It is a reasonable approach that implies data credibility. Further, it encourages and anticipates further improvements in the currently designated reference method samplers and any new candidate reference or equivalent methods. Significant improvements have been made to the two designated samplers, and additional improvements are anticipated, which should result in further reductions in the relative bias between these samplers. Manufacturers of new samplers should benefit from the experience with these initial samplers and should be better able to address or avoid the problems encountered in their use.

When the performance-based approach for specifying PM_{10} samplers was selected, the potential for bias between approved samplers due to effects not directly addressed by the wind tunnel performance tests (e.g., effects from soiling during field use) was recognized. It was anticipated that the magnitude of these effects would be relatively small, and when problems were identified that the manufacturers would take proper corrective actions. Although the relative bias between the first two designated reference method samplers is larger than anticipated, the manufacturers are working on correcting the problems. We believe that it would be premature at this point in time to presume that these problems are not solvable and that one of the other options for PM_{10} data treatment should be pursued.

These are compelling arguments in support of this approach. The disadvantages, while significant, appear to be substantially less serious than those listed for the other approaches and can be realistically accommodated. Accordingly, this option is recommended and, we believe, represents a valid, workable, and defensible approach to treatment of the observed relative biases among various PM_{10} samplers.

Given this recommendation, we recognize, nonetheless, that some variability in PM_{10} measurements may be due to instrument differences. Therefore, we encourage monitoring agencies to try to assure historical continuity in PM_{10} measurements by using comparable reference monitoring methods (e.g., same manufacturer) at the same location over time. Furthermore, when multiple instruments are used at the same location to perform every-other-day or everyday sampling, comparable methods should also be used.

II. TREATMENT OF PM_{10} DATA OBTAINED WITH UNAPPROVED SAMPLERS

There have been several types of unapproved PM_{10} samplers which have produced PM_{10} data over the last few years. The most prevalent data producers, by far, were older versions of currently approved high-volume samplers. Although used to a much lesser extent, dichotomous samplers have, nevertheless, produced a significant amount of PM_{10} data. Dichotomous sampler inlets have been changed or modified very little since their introduction, and comparative tests show generally consistent results that agree well with currently designated high-volume PM_{10} samplers. Designation of the first dichotomous sampler as reference method is anticipated soon. For these reasons, dichotomous data requires no special treatment and should be used at face value. Accordingly, the following discussion will focus only on alternative treatments of data produced by the earlier versions of the currently designated high volume PM_{10} samplers manufactured by Sierra-Andersen and Wedding & Associates, Inc.

OPTION 1: Use PM_{10} measurement data from unapproved methods at face value.

In this approach, all validated PM_{10} concentration data from any unapproved PM_{10} sampler are reported and used at face value with same authority as reference or equivalent method data. No special adjustments are made or special treatments are utilized.

Advantages

1. This approach is identical to the current EPA policy regarding the use of measurements from unapproved PM_{10} methods, even if these measurements were affected by a gray zone in the area grouping process. This policy is based on the judgement that the field study situation in Phoenix was atypical and that sampler agreement would be better in most areas without the pervasive large particles characteristic of the Phoenix test site.

2. This approach permits an area to make full use of PM_{10} data collected prior to the NAAQS promulgation in order to compile the 3 years of data generally needed to assess attainment with the standards.

3. This approach is simple to implement and requires no change in current policy.

Disadvantages

1. This approach ignores the reported bias between the earlier PM_{10} sampler versions. Recent field studies have shown that large biases exist in more locations than previously suspected.

2. This approach could cause an erroneous attainment or non-attainment determination.

3. This approach is inconsistent with data usage for other NAAQS pollutants in which data from non-reference or non-equivalent data is not used.

4. With the existing EPA guidance regarding the face-value use of data produced by unapproved samplers, monitoring agencies may want to demonstrate that adjustment factors are appropriate. This policy places a burden on the reporting agencies to demonstrate that the affected data were biased.

OPTION 2: Adjust PM_{10} measurements from unapproved methods with factors developed for each type of sampler on either (A) a universal, nationwide basis or (B) a site-specific basis.

Under this approach, all validated PM_{10} data collected with unapproved samplers would be adjusted in an attempt to reduce or eliminate the apparent biases between the different PM_{10} samplers.

Advantages

1. As indicated for the use of data produced by approved reference method samplers, this approach addresses the bias problem directly, and the adjusted data may be used via the same mechanisms used for other pollutants. In this case, adjustment factors may have to be established based on comparative test data from approved sampler versions if test data for the unapproved version is unavailable.

2. Use of site-specific adjustment factors would more effectively mitigate site-to-site variations in biases that would not be addressed with universal sampler adjustment factors applied nationwide.

3. The current EPA policy tentatively allows adjustment of older data on a local basis if bias can be demonstrated. This could involve development of factors derived from data obtained from collocated reference method and unapproved samplers.

Disadvantages

1. The development and application of factors for data obtained with unapproved methods have the same disadvantages as those for data obtained with approved samplers.

2. If factors were derived from collocated sampling with approved and unapproved samplers, the factors may be developed with data collected during one time period and applied to data collected during a different time period. This would involve making potentially questionable assumptions regarding similarities in sampling conditions (e.g., PM_{10} emissions, meteorology, and particle size distribution).

OPTION 3A: Use PM_{10} measurement data selectively by defining a particular specific sampler as "correct" or as the "reference sampler".

For completeness of the discussion, Option 3A is also included for the treatment of unapproved sampler data. With this approach, however, the selected sampler must be one of the reference samplers; therefore, data produced by any unapproved PM_{10} sampler would not be used for air quality assessment.

Advantages

1. If data from unapproved samplers were considered invalid, this approach would be entirely consistent with data usage for other criteria pollutants.

2. This approach is simple to implement.

Disadvantages

1. Although many measurements produced by unapproved PM_{10} samplers in some sampling situations are uncertain or may be potentially biased, these measurements are not totally useless. When measured PM_{10} concentrations produced by a sampler that is apparently biased lower than other samplers are greater than the level of the standard, there is a high probability that an exceedance has occurred. Similarly, when measurements by a sampler that is apparently biased higher than other samplers are less than the level of the standard, then there is a high probability that an exceedance has not occurred. These data, therefore, can play a useful role in demonstrating that a location is clearly in attainment or non-attainment.

2. Selection of measurements from only one PM_{10} sampler is not practical to consider for the same reasons discussed for the reference samplers.

3. Although application for approval of certain PM_{10} samplers has not yet been formally submitted to EPA, these samplers are unofficially recognized as producing relatively unbiased PM_{10} measurements. Such instruments include dichotomous samplers .

OPTION 3B: Use PM_{10} measurements selectively by using a "gray zone" in interpreting and using PM_{10} data from unapproved PM_{10} samplers.

With this approach, data would be reported and stored at face value. However, during use of the data, a "zone of uncertainty" (gray zone) would be associated with the PM_{10} measurements, as discussed under option 3B for measurements from approved samplers. The same zones used for the area grouping process (0 to +20 percent for the SA and 0 to -20 percent for the Wedding samplers) would be utilized for attainment determination and SIP development.

Advantages

1. The advantages discussed in Section I, Option 3B for the reference method samplers are also applicable to the unapproved samplers.

2. The use of the gray zone option does not require any direct adjustments to the monitoring data, but permits their selective use for attainment/ non-attainment determinations. The data may be helpful to support and corroborate a determination of attainment or non-attainment, or to establish that the status is indeterminate, in which case additional data would be required.

3. The use of the gray zone permits the use of nonreference data to support the determination of attainment or nonattainment for many areas (i.e., whose critical data is not close to the levels of the PM_{10} standards) while recognizing relative biases that may exist in those data.

Disadvantages

1. Gray zone treatment for older data is more likely to cause an area to have an indeterminate attainment status. This could potentially delay the SIP process for some areas with affected data. The delay would be due to extending the time period necessary to collect additional data for unequivocal attainment/nonattainment determination. However, this would primarily involve those areas which are borderline attainment/nonattainment.

2. Application of the gray zone approach to data collected with unapproved samplers after the time reference samplers were generally available could permit an additional delay in attainment/nonattainment determination for Group II areas and subsequent SIP development.

Recommendation

We believe that option 3B, use of data selectively by using a gray zone interpretation to support and corroborate data produced by reference samplers, is clearly the best course of action for measurements from unapproved SA and Wedding samplers. This approach recognizes the potential uncertainty in older PM_{10} measurements and reinstates a precedential policy that has been used successfully and with which people are already familiar. The same zones of plus or minus 20 percent would be utilized. Specifically, this translates to unapproved SA concentration ranges of 50 to 60 ug/m3 for the annual standard and 150 to 180 ug/m3 for the 24-hour standard. Unapproved Wedding sampler ranges are 40 to 50 ug/m3 and 120 to 150 ug/m3, respectively. Data within these ranges would be used with less authority than data outside these ranges. Alterations to this general rule could be considered on a case-by-case basis and must be discussed with OAQPS.

We recommend that the gray-zone policy only be applied to data produced by unapproved SA or Wedding samplers before August 1, 1988. This date is one year from the effective date of the PM_{10} regulations. After this date, the use of data produced by unapproved samplers is not permitted for determinations of attainment/nonattainment and calculation of design values (40 CFR Part 58.14(a)). With Regional Administrator approval, however, these data may be used for other SIP purposes (40 CFR Part 58.14(b)). We also note that older PM_{10} data from unapproved SA or Wedding samplers may no longer be needed for current air quality assessment when 3 years of data from approved samplers are available.

An effect of reinstating the gray zone approach may be a temporary delay in the immediate determination of attainment or nonattainment for some areas with older data from unapproved samplers in the gray zone (i.e., close to the standard). Control agencies with data affected by gray zones must recognize that these measurements represent potential exceedances and, therefore, they must anticipate the possibility of future control strategy development. Additional SIP development guidance may be needed for this situation (e.g., requirement of accelerated sampling, dispersion modeling, etc.).

Finally, we note that data produced by dichotomous samplers should be interpreted the same as data produced by EPA-designated samplers (i.e. at face value) but only to support measurements produced with reference samplers. However, as long as the dichot is not approved as a reference sampler, only data collected before August 1, 1988, may be used to support attainment assessment and calculation of design values. Nonetheless, these data may continue to be used for control strategy development and other SIP purposes with RA approval.

III. TREATMENT OF PM_{10} DATA OBTAINED CONCURRENTLY WITH COLLOCATED SAMPLERS

PM_{10} samplers may be collocated to produce concurrent measurement data at the same site for quality assurance, attainment assessment or other SIP purposes. The samplers may be operated by a single monitoring agency or by separate monitoring agencies (governmental, environmental or industry). The PM_{10} regulations specify different sampling and data requirements according to the intended application of the data. For attainment assessment and calculation of design values, monitors must meet all Part 58 requirements for SLAMS as well as minimum data requirements specified in Appendix K to 40 CFR Part 50. For quality assurance (QA) and other SIP purposes, monitors and data must only meet less stringent requirements.

Accordingly, where two or more PM_{10} samplers are collocated and operated simultaneously, treatment of the PM_{10} data from these samplers depends on the intended purpose of the measurement data and compliance with the appropriate regulatory requirement. In all cases, measurements from an approved sampler take precedence over measurements from unapproved samplers. If two (or more) approved samplers are collocated and operated concurrently by a single monitoring agency for any purpose, one sampler must be designated, at random, a priori as the primary sampler whose samples will be used to report air quality for the site. All other samplers are designated as duplicate or special purpose monitors (SPMs). This is established data reporting procedure and is described in Section 3.3 of Appendix A to CFR Part 58. In general, data from duplicate samplers are not used for attainment assessment; only the primary sampler's data are used. However, according to Appendix K to CFR Part 50, data from such duplicate monitors must also be used for assessing attainment if the appropriate SLAMS requirements (including sampling frequency) are met. Furthermore, separate monitoring agencies (governmental, environmental or industry) may be operating one or more approved collocated samplers which also meet all of the SLAMS requirements and whose data also meet the appropriate completeness requirements specified in Appendix K. When two agencies operate samplers at the same location, only one agency's sampler(s) are part of the SLAMS. The other agency's sampler's represent a special purpose monitoring site. However, the monitoring regulations specify that this data must be used as well. The data treatment issue is: how must this data be used?

The following discussion applies to the treatment of data for the purpose of attainment assessment where two or more approved samplers are collocated and operated concurrently by one or more separate monitoring agencies and each sampler meets all Part 58 requirements for SLAMS. The first three options discussed assume that each monitoring agency individually reports all its data to EPA. The user would perform the selected data treatment. The fourth option furnishes control of the data to the responsible monitoring agency, by permiting the agency to select and report a single set of data to represent the monitoring site. This data may be produced by a designated sampler or the daily average of measurements produced by several available reference samplers.

OPTION 1: Measurement data are submitted separately by each monitoring agency. The data user would average the corresponding measurements from approved samplers.

When multiple measurements are concurrently produced by two approved samplers and are reported to EPA, the ambient PM_{10} concentration estimated for the location would be the average of these measurements. When only one daily measurement is available in this situation, because other measurements are missing (e.g., due to sampler malfunction), the reported measurement would be used without correction. Similarly, the estimate of annual average PM_{10} for the location would be based on the average of the reference samplers' average PM_{10} concentrations. Daily values and annual reference samplers' averages would only be considered if the data were produced in accordance with the requirements of 40 CFR Part 58 and 40 CFR Part 50, Appendix K.

Advantages

1. When multiple measurements are available from approved reference or equivalent method samplers, each measurement is an estimate of the true PM_{10} concentration. If the errors associated with the measurements are random, a better estimate of the true value is usually produced by averaging the measurements. PM_{10} measurements produced by dissimilar samplers may be consistently higher or lower than one another, indicating that the errors are not totally random. Nevertheless, in the absence of absolute calibration standards, there is no information to indicate which measurement is the better estimate. Accordingly, averaging the measurements is appropriate.

Disadvantages

1. Averaging collocated measurements would cause inconsistency in estimation of daily and annual average PM_{10} concentrations. Some estimates would be produced by a single measurement from one instrument type while others would be the result of different samplers.

2. Averaging of collocated measurements would be a change to the air quality data usage conventions. Currently, when a single agency operates multiple samplers at a site, only the primary designated reference sampler's data is used for making comparisons with the NAAQS. Also, when multiple agencies operate monitors at the same location, the highest reported daily or average concentration is used for making comparisons with the NAAQS.

3. The public could complain that a NAAQS violation was "averaged away".

OPTION 2: Measurement data are submitted separately by each monitoring agency. The data user would select the highest concentration measurement produced by collocated samplers.

Advantages

1. When multiple measurements are available, a higher measurement would provide better protection of public health.

2. Using the higher measurement would help to discourage multiple monitoring agencies from collocating dissimilar samplers to obtain lower measurements.

3. In general, monitored concentrations underestimate the worst concentration in an area. This is due to the limited size of monitoring networks and the problem of finding the site of maximum pollutant impact. Air quality simulation models usually find higher concentrations due to the larger grid of receptors. For PM_{10}, monitored concentrations may also be low due to losses of semi-volatile or secondary particles (e.g., nitrates). Using the higher of duplicate measurements would tend to compensate for these effects.

Disadvantages

1. PM_{10} measurements produced by one reference sampler are not necessarily better than another.

2. If the two samplers were unbiased, relative to each other, then this approach would introduce bias in selected peak values. This is due to the effect of the imprecision of individual samplers.

3. With this approach, areas would be more likely to be determined as not in attainment with the standards. There would also be an impact, albeit small, on the design value and the development of control strategies.

OPTION 3: Measurement data are submitted separately by each monitoring agency. The data produced by each agency are treated as data produced by different sampling stations.

Advantages

1. This interpretation is consistent with historical data usage for collocated sampling by different monitoring agencies. It is also straigtforward, simple to implement and doesn't require any changes to existing data processing software.

2. The data produced by any monitoring agency using an approved reference method sampler that satisfies all of the pertinent Part 58 requirements can demonstrate that the site is in violation of the NAAQS and thereby be used to protect public health.

3. When two or more agencies operate the same type of PM_{10} sampler, treating the agencies' data separately avoids the bias that could be introduced by selecting the maximum daily collocated measurement. (See disadvantage 2 under option 2 above.)

4. The advantages 2 and 3 discussed under option 2 above are also applicable to this option.

Disadvantages

1. All measurements produced by approved collocated reference method samplers estimate PM_{10} air quality at a specific location. However, with this option for treatment of data, measurements from only one agency's samplers are sufficient to establish nonattainment, while measurements from each agency's approved samplers are necessary to demonstate attainment. Therefore, this approach favors a sampler which produces systematically higher measurements.

2. The disadvantages 1 and 3 discussed under option 2 above are also applicable to this option.

OPTION 4: Allow the responsible control agency to submit a single set of data for the location. This data set could be obtained by a) designating a primary approved sampler or b) averaging data from multiple approved samplers.

Advantages

1. The State would clearly be responsible for the one data set that would be used for attainment/non-attainment decisions.

2. Designation of one sampler as the primary sampler is consistent with existing duplicate sampler data usage, when a single monitoring agency is involved.

3. This approach provides flexibility to the responsible control agency in deciding how much weight should be placed on the supplemental information.

Disadvantages

1. Lack of specific guidance on how the additional measurement information would be used may produce inconsistent use of data nationally and present the potential for inconsistent data interpretation among States and Regional Offices.

2. Selective use of reference method data which meets all of the Part 58 and Appendix K requirements may be in conflict with Appendix K to CFR Part 50, which states that all data must be used. However, this approach does not specify a uniform procedure in which the supplemental data must be considered for attainment assessment.

3. In the case of averaging data, State Agencies might feel that the impact of their data is being diluted by being combined with data from other sources. Also, unless submission of all data for each monitor is required there would be no record of the individual State monitor measurements.

4. This approach may be viewed as a departure from existing data usage conventions wherein the highest reported values are currently used in a multiple agency situation for all pollutants.

Recommendation

For the case when samplers are collocated for data quality assessment purposes (i.e., precision and accuracy), it seems reasonable to recommend that similar sampler types must be used, and one sampler must be designated _a priori_ for data reporting purposes. Furthermore, if more than one type of sampler is used by a reporting organization, collocated precision sites should be established for each sampler type.

When more than one sampler is operated by one or more monitoring agencies for attainment assessment purposes, we recommend Option 3, treating each agency's data as data produced by a different sampling station. We feel that this option is more legally defensible, is consistent with existing interpretation of NAAQS pollutant measurement data, and supports the Federal Reference Method approval process. We do expect the multiple agency sampling situation to be common and certainly do not encourage the collocation of different sampler types for routine air quality monitoring and data reporting.

With a multiple agency sampling situation, one monitoring station shall be designated as the SLAMS station and the others shall be designated as SPM stations. Any special purpose ambient air quality monitoring station, from which the State intends to use the data as part of a demonstration of attainment or nonattainment or in computing a design value for control purposes of the NAAQS, must meet all the requirements for SLAMS (40 CFR Part 58.14), including quality assurance, monitoring methods, and probe siting. This requires that a quality assurance program be described in detail, suitably documented and approved by the appropriate Regional Office (40 CFR Part 58 Appendix A).